

Respiratory Symptoms in Indian Women Using Domestic Cooking Fuels*

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The effect of domestic cooking fuels producing various respiratory symptoms was studied in 3,701 women. Of these, 3,608 were nonsmoking women who used four different types of cooking fuels: biomass, LPG, kerosene, and mixed fuels. The overall respiratory symptoms were observed in 13 percent of patients. Mixed fuel users experienced more respiratory symptoms (16.7 percent), followed by biomass (12.6 percent), stove (11.4 percent), and LPG (9.9 percent). Chronic bronchitis in chulla users was significantly higher than that in kerosene and LPG

users ($p < 0.05$). Dyspnea and postnasal drip were significantly higher in the women using mixed fuels. Smoking women who are also exposed to cooking fuels experienced respiratory symptoms more often than nonsmokers (33.3 percent vs 13 percent). (Chest 1991; 100:355-359)

ANOVA = analysis of variance; COHb = carboxyhemoglobin; LPG = liquified petroleum gas; MRC = Medical Research Council

Domestic cooking is one of the important functions for the average Indian housewife. The number of hours spent in the kitchen for domestic work and cooking is variable depending on the burden of extra work. On an average, an Indian housewife spends about six hours in the kitchen daily for cooking food and other purposes and because of sociocultural reasons, she is exposed to the fuel at an early age of about 15 years. Therefore, during her lifetime, she is exposed for 30 to 40 years, equivalent to 60,000 hours. The location of the kitchen, the type of ventilation, and the type of fuel used play a significant role on health. In most urban areas, the kitchens are located within the main house and the ventilation is generally good. In rural houses, most of the cooking is carried out in an enclosed space with poor ventilation because of cultural reasons and seasonal variations.

The type of cooking device used also is significant as far as indoor air pollution is concerned. Commonly, four types of cooking devices are available throughout this country. These include (1) kerosene stove (wick type or pressure type); (2) coal-lighted "angithi"; (3) gas stove operated by liquified petroleum gas (LPG); and (4) "chulla" in which biomass fuels (dried dung, crop residues, and agricultural wastes) are used. The amount of indoor air pollution or morbidity and mortality produced by these fuels has been discussed by various authors.¹⁻⁴ Padmavati and Arora⁵ had suggested that the development of chronic bronchitis and

cor pulmonale in nonsmoking rural women may be due to the exposure to the smoke during cooking. In a preliminary study, Malik⁶ had reported chronic bronchitis contributed by indoor air pollution in nonsmoking women. In the present study, an attempt is made to find out various respiratory symptoms in women using different cooking fuels.

MATERIAL AND METHODS

A house-to-house survey was carried out in five villages situated about 5 km south of the Chandigarh city in Northern India. The area is free of any industrial or general atmospheric pollution. The villagers live in mud-walled or semi-pucca type of houses. The common cooking devices include chulla using biomass fuel, gas stove using LPG, kerosene stove, or a combination of two or more of these. The eligible population for this study consisted of every woman engaged in household cooking. The defined population numbered 4,259.

Detailed respiratory symptoms were revealed in a standard questionnaire adapted from that of the British Medical Research Council (MRC), and chronic bronchitis was diagnosed from the presence of cough with expectoration for three months in a year for at least two consecutive years on the recommended criteria of MRC.¹⁰ Other symptoms noted were cough (falling short of the definition for chronic bronchitis), dyspnea in the absence of any clinical cardiopulmonary disease or severe anemia and obesity, bronchial asthma diagnosed on the history of episodic cough with wheezing, presence of rhonchi, response to bronchodilators, and postnasal drip. Basic demographic data, smoking history, location of the kitchen, adequacy of ventilation, and the type of cooking fuel used were also noted. Exposure index was calculated as the average number of hours spent daily for cooking multiplied by the number of years of cooking. Height was measured with the subject standing and without shoes.

The survey team consisted of one social worker, one technician, and a medical physician. The same team surveyed the whole population and the questionnaire was administered and filled out by the social worker after carefully explaining each question to the individual. A detailed physical and clinical examination was done by the visiting physician. Spirometry was carried out by means of a portable electronic spirometer (Spiroscreen, Gould, Singapore).

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Table 1—Age, Height, and Exposure Index of the Subjects (Mean \pm SE)

Fuel	Age, yr	Height, cm	Exposure Index
Chulla			
Symptomatic n = 126	36.9 \pm 1.1	153.5 \pm 0.5	77.5 \pm 4.8
Asymptomatic n = 674	29.0 \pm 0.4	153.1 \pm 0.2	56.1 \pm 1.7
p value	<0.001	>0.05	<0.001
Stove			
Symptomatic n = 129	29.6 \pm 0.6	152.3 \pm 0.6	43.2 \pm 3.1
Asymptomatic n = 1,000	27.1 \pm 0.2	152.0 \pm 0.2	35.3 \pm 0.9
p value	<0.01	>0.05	<0.05
LPG			
Symptomatic n = 48	34.9 \pm 1.8	153.1 \pm 0.8	53.1 \pm 5.8
Asymptomatic n = 437	31.5 \pm 0.5	153.0 \pm 0.3	48.1 \pm 2.0
p value	>0.05	>0.05	>0.05
Mixed			
Symptomatic n = 166	33.8 \pm 0.9	153.4 \pm 0.4	52.4 \pm 3.6
Asymptomatic n = 626	26.2 \pm 0.4	152.2 \pm 0.2	36.9 \pm 1.2
p value	<0.001	>0.05	<0.001

after explaining and demonstrating the procedure to each individual. Three graphs were obtained in each patient and the best one was chosen as the representative value for the individual.

The survey team was first trained in the laboratory in the technique of interviewing and carrying out spirometry. Periodic checking was done to verify the accuracies of the survey by a senior consultant of the department.

Data were analyzed by means of statgraphics v 3.0 on a computer (IBM PC XT): Cross table χ^2 test and analysis of variance (ANOVA) was used for statistical analysis.

RESULTS

A total of 3,716 women were studied that covered 67.3 percent of the total female population. The remaining 13 percent of the women could not be studied because either they did not consent to participation or they could not be contacted on repeated visits. After excluding those with history of smoking (n = 93, 2.5 percent) and other concomitant diseases (n = 17), a total of 3,608 nonsmoking women were analyzed for the presence of respiratory symptoms. There were mainly four types of cooking fuels used by these women: chulla (biomass fuel); stove (kerosene oil); liquified petroleum gas (LPG); and mixed fuels such as a combination of two or more.

Table 1 shows the distribution of age, height, and exposure index in the population studied. The symptomatic women had higher age (p < 0.05 to 0.001)

except the LPG users. Similarly, the symptomatic women had higher exposure index in all fuel groups (p < 0.05 to 0.001) except the LPG users. The height was similar in all the groups. Table 2 shows different types of respiratory symptoms encountered by different fuel users. Mixed cooking fuels produced respiratory symptoms in 16.7 percent of the women. About 13 percent of chulla users and 11 percent of stove users encountered various respiratory symptoms. The overall respiratory symptoms were 13 percent in all groups of women. χ^2 tests across all cooking device categories revealed statistically significant differences in the symptoms (p < 0.01) and then individual comparisons were made using the χ^2 test. Chronic bronchitis in chulla users was significantly higher than that of kerosene stove and mixed fuel users (p < 0.05). Mixed fuel users experienced dyspnea and postnasal drip more often than other fuel users (p < 0.05). The prevalence of respiratory symptoms was more with increased exposure index in all the four groups of fuel users (Table 3). Table 4 gives various symptoms in smoking women using different fuels. Lung function parameters are given in Table 5. It was observed that asymptomatic women had higher values (percent predicted) for most of the parameters compared with symptomatic women (p < 0.05 to 0.01) except in the LPG group and in the mixed fuel users where the predicted FVC and FEV₁ values were comparable. Chulla users had lowest values for all four parameters (both symptomatic and asymptomatic).

DISCUSSION

It is well established that all types of cooking fuels produce respiratory irritants such as oxides of nitrogen, sulphur dioxide, and unburnt hydrocarbons (soot particles).^{12,13} Soot particles that are generated more with fire wood cooking chulla are probably more hazardous in causing changes of chronic bronchitis as well as airways obstruction. Chronic bronchitis in nonsmoking women has been reported to vary between 0.44 percent and 4.96 percent by various investigators from this country.¹⁴⁻¹⁷ Wig et al¹⁴ from Delhi had reported quite low frequency of chronic bronchitis in the rural nonsmoking women (0.44 percent). However, Malik and Behera¹⁵ have reported

Table 2—Comparison of Symptoms in Different Fuels (Nonsmokers)*

Fuel	Number studied	Chronic bronchitis*	Cough	Dyspnea†	Bronchial Asthma	Postnasal Drip‡	Total§
Chulla	1,000	29 (2.9)	10 (1.0)	77 (7.7)	5 (0.5)	5 (0.5)	126 (12.6)
Stove	1,129	15 (1.3)	9 (0.8)	75 (6.6)	10 (0.9)	20 (1.8)	129 (11.4)
LPG	485	12 (2.5)	3 (0.6)	27 (5.6)	1 (0.2)	5 (1.0)	45 (9.9)
Mixed	994	12 (1.2)	6 (0.6)	121 (12.2)	6 (0.6)	21 (2.1)	166 (16.7)
Total	3,606	66 (1.9)	26 (0.8)	300 (5.3)	22 (0.6)	51 (1.4)	469 (13.0)

*chulla vs stove and mixed p < 0.05, †mixed vs chulla and stove p < 0.05, ‡mixed vs chulla p < 0.05, §mixed vs LPG p < 0.05

Numbers in parentheses indicate percentage.

Table 3—Symptoms According to the Exposure Index*

Exposure Index	Fuel							
	Chulla		Stove		LPG		Mixed	
	Symptom No.	Total No.	Symptom No.	Total No.	Symptom No.	Total No.	Symptom No.	Total No.
<20	21 (6.8)	309	37 (8.9)	417	9 (6.5)	319	41 (12.02)	340
21-30	12 (13.5)	89	21 (10.3)	204	8 (14.3)	56	22 (15.0)	147
31-40	10 (10.2)	98	19 (12.6)	151	6 (9.4)	64	24 (21.1)	114
41-50	11 (18.03)	61	11 (12.6)	87	4 (8.7)	46	15 (14.1)	107
>50	72 (16.2)	443	41 (15.2)	270	21 (11.7)	180	64 (22.4)	286

*Numbers in parentheses indicate percentage.

Table 4—Respiratory Symptoms in Smoking Women Exposed to Cooking Fuel*

	Number Studied	Chronic Bronchitis	Cough	Dyspnea	Postnasal Drib	Total
Chulla	19	3 (15.8)	—	3 (15.8)	—	6 (31.6)
Stove	24	—	1 (4.2)	2 (8.3)	3 (12.5)	6 (25)
LPG	1	—	—	—	—	—
Mixed	49	7 (14.3)	2 (4.1)	10 (20.4)	—	19 (38.8)
Total	93	10 (10.7)	3 (3.2)	15 (16.1)	3 (3.2)	31 (33.3)

*Numbers in parentheses indicates percentage.

a higher prevalence rate up to 4.96 percent from Chandigarh. Charan,¹⁶ in a large study from rural Punjab, reported chronic bronchitis in 53 (0.74 percent) of 7,132 subjects. These studies have not paid particular attention to the role of cooking fuels, although speculation was made about its role in the causation of chronic bronchitis. Thiruvengadam et al¹⁷ from Madras (Southern India) have also reported the prevalence of chronic bronchitis to be 1.5 percent in female subjects. Similarly, a low prevalence of chronic bronchitis has been reported from Nigeria (0.24 percent),¹⁸ Zimbabwe (2.8 percent),¹⁹ Japan (3.1 percent),²⁰ and Uppsala (1.5 percent)²¹ in nonsmoking

women. However, only one study from Nepal⁸ has shown a high prevalence of chronic bronchitis in 12.57 percent cases of nonsmoking women and directly attributed to domestic smoke pollution, particularly biomass fuel. Our present study shows an overall prevalence of chronic bronchitis of 1.9 percent and when analyzed for different cooking devices, it was 2.9 percent for chulla users. Cough, as reported by some women, does not fit the definition of chronic bronchitis. Perhaps these are a subset of patients with chronic bronchitis, and if history is taken, they will be diagnosed as having chronic bronchitis. Then the overall incidence will rise to 2.7 percent, which is still

Table 5—Lung Function Data (Percentage Predicted) in the Subjects Studied (Mean \pm SE)*

Fuel	FVC	FEV ₁	PEFR	MMF
Chulla				
Symptomatic n = 126	71.56 \pm 1.51	83.21 \pm 1.89	63.43 \pm 1.86	91.85 \pm 3.02
Asymptomatic n = 845	76.53 \pm 0.39	88.82 \pm 0.57	67.77 \pm 0.80	99.55 \pm 0.96
p value	<0.01	<0.01	<0.05	<0.05
Stove				
Symptomatic n = 129	77.50 \pm 1.27	88.78 \pm 1.43	68.64 \pm 1.81	93.67 \pm 2.80
Asymptomatic n = 977	80.14 \pm 0.37	90.29 \pm 0.42	69.87 \pm 0.60	97.70 \pm 1.11
p value	<0.05	>0.05	>0.05	>0.05
LPG				
Symptomatic n = 48	78.71 \pm 1.75	92.14 \pm 2.18	66.07 \pm 3.49	96.65 \pm 4.38
Asymptomatic n = 426	77.98 \pm 0.65	91.20 \pm 0.78	68.57 \pm 1.03	101.14 \pm 1.61
p value	>0.05	>0.05	>0.05	>0.05
Mixed				
Symptomatic n = 166	75.81 \pm 1.17	87.63 \pm 1.40	65.87 \pm 1.62	94.06 \pm 2.26
Asymptomatic n = 797	77.39 \pm 0.44	88.99 \pm 0.61	70.74 \pm 0.70	100.22 \pm 0.99
p value	>0.05	>0.05	<0.01	<0.05

*PEFR = peak expiratory flow rate; MMF = mean maximum flow.

far less than that reported by Pandey⁸ from Nepal, although it is similar to that reported from this country as well as from elsewhere. The discrepancy between the Nepal study and the present one is perhaps due to total absence of ventilation facilities in Nepal houses producing much more pollution than the Chandigarh villages.

LPG or kerosene stove cooking, specifically the former, which is considered traditionally to be safe fuel, also produces a significant amount of respiratory symptoms. Dyspnea was one of the major complaints in these symptomatic women. In the absence of cardiopulmonary disease, severe anemia, or obesity, this symptom is quite interesting. It is possible that an average woman mistakes fatigue as dyspnea. According to Burney et al.,²² high levels of blood carboxy-hemoglobin (COHb) may also be responsible for dyspnea. Although we have not measured COHb in these women, in an earlier study we have shown that high levels of COHb are seen in subjects exposed to biomass fuel.²³ Whether this is enough to explain dyspnea is not very clear.

Bronchial asthma, as mentioned in some cases, is unlikely to be due to cooking fuels. However, if such a patient is exposed to domestic fuel producing smoke, the symptom will be aggravated.

In an earlier study²⁴ in 642 teachers from the city of Chandigarh (urban population), we had observed bronchial asthma in 3.2 percent of female subjects and dyspnea was reported in 4.9 percent of non-smoking women. However, in the present study, in rural female subjects the symptoms were observed in 0.6 percent and 5.3 percent of subjects, respectively. This low incidence of bronchial asthma may not reflect the true prevalence since many patients with cough and dyspnea might be suffering from this condition. Evaluation of the adequacy of ventilation in production of the symptoms was difficult since quantification was not possible. However, we believed that, although most of the houses had provision for ventilation in the kitchen, this was not adequate. Thus, exposure to domestic cooking fuels produced a significant amount of respiratory morbidity. Use of smokeless devices and provision of adequate ventilation might be helpful to prevent some of these effects. Moreover, smoking women exposed to cooking fuels experience respiratory symptoms more often than nonsmokers.

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